E.S.O. 273

FIVE YEARS OF COMPUTER-ASSISTED INSTRUCTION: THE AGRICULTURAL ECONOMICS EXPERIENCE WITH INSTRUCTIONAL TECHNOLOGY

by

John T. Whinnery

David E. Hahn

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY

THE OHIO STATE UNIVERSITY

COLUMBUS, OHIO

AUGUST, 1975

"Five Years of Computer Assisted Instruction: The Agricultural Economics Experience with Instructional Technology"

John T. Whinnery and David E. Hahn, The Ohio State University

CAI has been a successful teaching technique for supplementing classroom presentations in Introductory Agricultural Economics. Student attitudes favor CAI use and performance improves significantly, independent of instructor. Multisectional courses have uniform content and extensive evaluation is possible. Course segments cover production principles and related cost concepts, investments, and elasticity.

Keyword Listing: Computer Assisted Instruction; CAI; Instructional Methods; Student Performance; Teaching Agricultural Economics

FIVE YEARS OF COMPUTER-ASSISTED INSTRUCTION: THE AGRICULTURAL ECONOMICS EXPERIENCE IN EDUCATIONAL TECHNOLOGY

John T. Whinnery and David E. Hahn*

Background

The instructional arrangements that characterize higher education are being called into question today as never before. Efficiency in education, faculty accountability, evaluation of teaching, all are being discussed by sectors of society that once believed such topics to be the sacrosanct province of academicians themselves.

It is to the credit of Colleges of Agriculture that serious introspection concerning our educational objectives has been a long-time activity. Further, there has been continuing commitment in our profession to improving the functioning of higher education in agricultural economics. As of yet, however, there is no concensus about defining quality education or superior teaching. On elements of such definitions there is agreement: the superior teacher is professionally competent, enthusiastic about his profession, and his teaching, and concerned about students and their educational progress. A quality educational program is one that provides a variety of learning experiences toward a specific objective.

Albert Einstein claimed that he was not particularly intelligent, he was just curious. He also stated that it was nothing short of a miracle that

---

*Coordinator, Socioeconomic Information and Associate Professor, respectively, Department of Agricultural Economics and Rural Sociology, The Ohio State University, Columbus, Ohio.

modern methods of instruction had not yet entirely strangled the holy spirit of curiosity. In recent years, however, there has been increasing interest in modern methods of instruction as a means of rekindling the spirit of curiosity that is so closely tied to learning. Charles E. French, in his presentation to this group last year, made a strong case for use of a wide variety of modern techniques for bringing real-world situations to undergraduate students. Dr. French indicated only one-half dozen Agricultural Economics departments were making effective use of advanced teaching techniques. Einstein notwithstanding, French is not alone in his plea for sensible supplementation of the classroom lecture.

Realizing that student "carryaway" capacity in head or notebook is about 40% of the content of a lecture, and that there is no single instructional panacea, what techniques are available and how do they affect student achievement?

Table 1 shows methods currently used in teaching, and summarizes how well these various forms of instruction accomplish educational goals. While it is apparent that no single method meets all criteria, Computer-Assisted Instruction (CAI) is more likely to result in transfer of learning and positive attitudes than most other methods of instruction. The balance of this paper will demonstrate that this assessment of the worth of CAI has been substantiated here at The Ohio State University.

CAI, as it is structured at Ohio State, serves to provide individualized instruction <u>supplemental</u> to classroom presentations. CAI is a form of

Table I

	Directs Attention	Promotes Motivation	Maintains Interest	Provides Immediate Feedback	Allows Student to Progress at His Own Rate	Avoids Excessive Frustration and Failure	Promotes Transfer	Develops Positive Attitudes
Discussion	Usually	Usually	Usually	Yes	Usually	Usually	Can, with a little effort	Usually
Games	Does, but indirectly	Usually	Usually	Yes	Usually	Often does not	Seldom	Usually
Lecture	Can, with a little effort	Can, but often fails to	Can, but often fails to	No	Rarely	Usually	Rarely does without special care	Can, if interesting
Programed Instruction	Almost always	Does, at least in beginning	Depends on material	Yes	Yes	Usually	Usually does not	Uncertain
Projects	Usually	Usually	Usually	Yes, when projects or parts of it are completed	Usually	Often does not	Often does not	Does, if project is successful
Recitation or Drill	Always	Rarely	Rarely	Yes, when oral. No when written	Usually, but not for better students	Rarely	Rarely, if ever	Rarely, if ever
Simulations	Often does not	Usually	Usually	Usually, depending on specific simulation	Usually	If well designed	Always, if simulation is adequate	In majority of cases
*Computer Assisted Instinction	Almost always	Does, esp. in beginning	Depends on presentation of material	Yes	Yes	Yes	Can if well designed	In majority of cases

self-instruction employing small learning steps, student response to each step, and immediate feedback to the student after each step. It requires substantial computer facilities, here provided by an IBM 360/128 high speed digital computer and the Coursewriter III conversational programming language. Ohio State students have available 94 hours of access time weekly, on 65 public access typewriter-type terminals in 20 locations across campus. Presently, 45 courses are receiving extensive student use in about 20 departments, and 20 more courses are in some stage of development. In a typical quarter term, our CAI system has about 15,000 hours usage. This figure has grown from less than 4,000 in 1971. A small central staff has provided development assistance and initial programming assistance to departments interested in developing CAI courses.

CAI in Agricultural Economics

In 1970, two professors in the Department of Agricultural Economics and Rural Sociology* began investigating ways of more effectively dealing with large numbers of students taking Agr. Econ. 100.

This introductory course in agricultural economics at The Ohio State University introduces the student to basic economic principles. It is a required course for most of the students in the College of Agriculture and Natural Resources, being taken during the students' freshman or sophomore years. The course is taught in sections of approximately 75 students, meeting five days per week with the same instructor. The approximate annual enrollment is 1,200 students.

---

*Dr. Glenn C. Himes and Dr. David E. Hahn

An important segment of the course deals with production principles and the related cost concepts. These concepts are difficult for many of our students to master. Many students, therefore, need a supplement to the text and classroom discussions to adequately grasp the material in the alloted time.

After consideration of a number of alternative methods, Computer-Assisted Instruction was selected as the method for providing supplemental teaching of production principles. CAI met a number of important criteria: 1) It could provide realistic problem situations that reinforced the learning process; 2) It provided the opportunity for the student to schedule his own learning experience; 3) It provided immediate feedback, giving the learner continuous knowledge of his progress; 4) It permitted the student to proceed through the material at his own pace; 5) It provided comparable treatment of subject matter topics in a multisection course; 6) The programs could be authored by the instructors themselves; 7) The programs and language were very flexible, allowing personalized interaction; 8) It provided extensive record keeping and evaluative capabilities; and, 9) It provided a review tool for students enrolled in advanced courses in agricultural economics.

The instructional material includes six major segments on the basic production principles, related short run cost concepts, investment analysis and elasticity. While these segments are logically sequential, each one is self-contained and may be taken independently of the others.

Following each learning experience, the student is questioned to learn if the concept was comprehended. Each answer is compared with

known correct answers, anticipated wrong answers and unanticipated answers.

With a correct response from the student, the program branches into the next unit of the CAI materials. For an anticipated wrong answer or unanticipated answer, however, additional tutoring or explanation is provided. This amplification of the topic allows additional exposure to the material and enhances retention by linking new material to existing concepts.

The interface between the student and the computer is a teletypewriter terminal. However, the degree of typing skill required of a student is minimal as his answers are usually single words or numbers. The student may keep the typed copy of the questions and his answers for review.

The personalization of the material through frequent use of the students' name and previous responses gives each learner a proprietary interest in the material. Students with such ego involvement are more likely to learn and remember the material, and are more likely to incorporate the salient concepts in future situations.

Attitudes and Performance

A study was conducted to evaluate student attitudes toward this program during the spring quarter of 1971. The primary objective of this study was to analyze student reactions and attitude changes brought about by exposure to the CAI materials developed for the course. The participating class consisted of 59 students; 53 males and 6 females. The results showed that auto-tutorial instruction provides individual attention not available in large classes (see Appendix for details of the study).

A major concern with CAI was the degree to which it assisted students in the learning process. It was hypothesized that students utilizing CAI materials would have a better understanding of the material than students not having access to these materials. Examination scores were used as the measure of evaluation.

Higher midterm test scores were achieved in the sections of the course utilizing CAI. The two sections not utilizing CAI had a mean test score of 60.6 (from a possible total of 84 points), while the two sections utilizing CAI had a mean test score of 64.9. This treatment difference was significant at the 1 percent level (Table 3, Appendix).

Test scores were also evaluated to determine if a statistical difference existed between instructors. The mean scores for Instructors A and B were 61.8 and 63.5, respectively. This interaction effect was insignificant and indicates that the treatment effect existed independent of instructors. Hence, the students had a similar learning experience from each of the instructors.

The evaluation of student attitudes toward CAI revealed favorable student acceptance of this type of supplemental teaching method. Student performance measured by exam scores was higher for sections of the course utilizing the CAI materials. Because of these results, the program continues to be regularly used in the course. Additional materials have recently been developed for this teaching method, including a course segment on investment analysis and one on the concept of elasticity. Under development are

segments on the futures market and instruction in use of computer analysis techniques extant on other systems.

Extensive student course evaluation has been a continuing activity in our Department, especially for the Agr. Econ. 100 classes. The sections of this ongoing evaluation dealing with Computer-Assisted Instruction continue to reflect a high degree of student acceptance for this method of instruction.

James Kendrick, at a recent workshop on the improvement of education in agricultural economics, discussed techniques for motivating students. His discouraging remarks about CAI focused on the inordinate resources such a method involves, the time required, and the overall complexity of the courses. It is true that as the name implies, a computer system must be available. It is true that development expense is high, 75 to 100 hours for each student hour compared to 10 to 15 hours per hour for classroom time for a first-time course developed conventionally.

Business, industry, and education professionals agree that the value of CAI warrants the costs where lectures are required, large numbers of people are receiving instruction, there is substantial future requirement, and where redundancy in presentation of the material is beneficial.

On the basis of our own experience (and using Kendricks' own terminology), CAI is a gimmick the lazy instructor cannot afford to overlook. We believe that a CAI program in agricultural economics is well within the developmental capacity of most departments in the country.

Student course evaluations in two recent quarters indicate the staying power of CAI as an instructional technique, both in terms of student acceptance and of value to their learning experience in agricultural economics. Of those students using CAI, 73% felt the method was very helpful in understanding course materials. The lasting quality of student attitudes toward our course is demonstrated by the fact that 65% of the students felt that CAI was useful or very useful in making the course more interesting.

When we find better than three out of four recent students rating their experience with CAI as useful or very useful, it certainly justifies the development energy expended.

Our course developed as the result of "hybrid vigor." Agriculturalists have relied on this established principle for well over a century, and with good reason. Genetically stated, increased fruitfulness occurs as a specific result of unlikeness in the constitution of uniting parental elements. Put another way, combining unlike input elements results in output that is better than either input or: the whole is greater than the sum of its parts.

This is essentially what happened with the Agecon program. The developers, Dr. Himes and Dr. Hahn, were concerned and rightly so with the content in terms of economic production principles, and the sequencing of that content in a logical manner.

They concentrated on the what, the where, and the when of the CAI material--and not on the how, the style or the presentation of the concepts; they got it down and got it going. They embraced the concept of hybrid vigor, and fortunately were not afflicted to any serious degree by disciplinary provincialism.

They knew that once the novelty of a new method and the Hawthorne effect had worn off, then the effectiveness of the program might diminish. In five years, we have determined that the effectiveness of our CAI program has a lasting quality. This stems in large part from our view of CAI as a communication medium, nothing more or less. Those of you with experience in audio and/or visual or other-assisted instruction will agree that this is the only justifyable stance.

We know that when the medium changes, the message changes also. A lecture that is televised is absolutely no better--and often incredibly much worse, than one given in person if the lecturer forgets that "when the medium changes the message must change." This statement has great implications for developers of CAI courses or any other educational technology, regardless of discipline.

In spite of the idea that it is often good to leave well enough alone, and after the favorable attitude response testing mentioned previously, we began to rewrite the entire Agr. Econ. course a few quarters after its introduction. The original program had used a role playing format wherein the student took the part of "Counselor" to a farmer who was trying to improve the production on his farm. When the student faltered or needed additional information, an "Advisor" came on and provided this. We retained this role playing format because it was a different and effective method of presentation. We did change the style, and you could call the program flavor "Southr'n Ohia Country."

The coursewriter language used for CAI at Ohio State has an "Unanticipated Response" record capability which is a valuable source of feedback. Just as stable systems make use of negative feedback, the negative feedback from the unanticipated responses can be very helpful to CAI authors. We have used these continuously to modify and update and improve our course program, disregarding the normal scatological comments and references to the author's parentage, of course.

The idea of a team approach is not new in CAI development. Leaders in the area have suggested the approach for a number of years and it certainly has worked for us. Our current program has met with very good student acceptance. As one female student put it recently during finals week, "It's more fun studying with the computer than reading your notes alone."

Experience gained in our teamwork on the Agecon CAI program has been and continues to be a guiding factor in our development and utilization of other modern instructional techniques.

We are entering an era of reemergence of instruction as the preeminent activity of colleges and universities. This era will find the dedicated instructor creating and managing a total learning environment. The combination of learning theory and technology so necessary for the future can increase efficiency in education and assist in faculty evaluation and thereby accountability.

APPENDIX

Materials from Attitude and Performance Evaluations
of CAI in Agricultural Economics at
The Ohio State University

In order that student reactions to the use of CAI could be analyzed, an attitude test was administered to the sample prior to and immediately following CAI exposure. Responses on a five point scale to the attitude statements after CAI exposure generally exhibited attitudes that were interpreted to be more favorable toward auto-tutorial instruction. Twelve of the eighteen statements showed a significant change in attitude at the 95% level or above (see Table 1).

The four sections of the Agricultural Economics 100 course taught during winter quarter, 1973, were divided into two control and two treatment groups (Table 2). Each section contained approximately the same number of students.

The sequence of the control and treatment sections were reversed for each of the two instructors to eliminate any carry-over effect from one section to another. The classroom format was further standardized by using a common course outline and a coordinated set of lecture notes. A conscious effort was made by each instructor to offer an "identical course" between instructors and between assigned control and treatment sections.

The results in Table 1 showed that the most significant difference in the means of pre-CAI and post-CAI responses occurred in attitude statement 11, dealing with the ability of auto-tutorial instruction to provide adequate individual attention. Comparison of the responses showed that thirty of the fifty-nine students in the sample had shifted toward agreement that auto-tutorial instruction does provide adequate individual attention after exposure to CAI not available in large classes.

Table 1. ATTITUDE STATEMENTS AND MEAN RESPONSES BEFORE AND AFTER CAI WITH T-VALUES FOR DIFFERENCE IN MEANS

	Attitude Statement	Mean Before CAI	Mean After CAI	T-Value
1.	I prefer the standard (conventional) form of education to auto-tutorial instruction.	2.186	2.831	3.564**
2.	Auto-tutorial instruction helps the student conceptualize concepts better than lectures.	2.610	3.305	4.064**
3.	Being able to ask questions in class is important.	1.542	1.407	1.262
4.	I like the freedom auto-tutorial instruction provides.	3.508	3.898	2.280*
5.	Most students would use auto-tutorial facilities much more if they were located in convenient places.	2.203	1.898	2.280*
6.	I like being able to go to an auto-tutorial facility at my convenience rather than being required to go to a scheduled class.	3.729	3.627	.551
7.	The use of auto-tutorial instruction is of little help to me since I cannot ask questions as I go.	2.780	3.576	4.851**
8.	Auto-tutorial instruction is better than teacher contact in learning routine concepts.	2.610	2.525	.478
9.	I can learn more by studying my notes and reading the text than by going to a listening booth or some other auto-tutorial facility.	2.831	3.610	4.898**
10.	I would like to be able to go to an auto-tutorial facility to learn basic information for my courses.	3.593	3.808	[illegible]**
11.	Auto-tutorial instruction does not provide adequate individual attention.	2.339	3.169	[illegible]**
12.	I would like to be able to go to an auto-tutorial facility to review basic information for my courses.	3.950	4.220	[illegible]*
13.	Auto-tutorial instruction is probably a waste of my time.	3.610	4.237	[illegible]**
14.	Computers provide many useful services for our society.	4.237	4.458	1.714
15.	Computers are too complex to be useful to me.	3.644	[illegible]	[illegible]**
16.	I would like to take a course in computer programming.	3.085	[illegible]	[illegible]
17.	The computer diminishes the importance of the individual in our society.	3.102	[illegible]	[illegible]*
18.	Computers perform many routine tasks in our technological age.	4.136	[illegible]	[illegible]

** Significant at 99% probability level.
* Significant at 95% probability level.

Table 2. EXPERIMENTAL DESIGN FOR EVALUATING EFFECTIVENESS OF CAI, The Ohio State University, 1973

Time of Class	Instructor	Treatment
9 a.m.	A	No CAI (Control)
10 a.m.	B	CAI (Treatment)
11 a.m.	A	CAI (Treatment)
2 p.m.	B	No CAI (Control)

Table 3. STUDENT PERFORMANCE AND INSTRUCTOR DIFFERENCES FOR CONTROL AND TREATMENT SECTIONS OF AGRICULTURAL ECONOMICS 100, The Ohio State University, 1973

Instructor		CAI	No CAI	Instructor Total	Instructor $\bar{X}$	
A	Class Size	51	66	117	61.8	
	Time	11 a.m.	9 a.m.			$F_{1, 261} = 1.05$
B	Class Size	83	65	148	63.5	
	Time	10 a.m.	2 p.m.			
Treatment Total		134	131	265		
	$\bar{X}$	64.9	60.6		62.8	

$F_{1, 261} = 6.76$

After CAI exposure, only two students agreed with statement 13 indicating they felt auto-tutorial instruction was probably a waste of their time. After CAI exposure, thirty-three students responded that auto-tutorial instruction was a better use of their time than they had previously thought.

Statements 1, 2, and 9 compared auto-tutorial methods to standard or conventional forms of education. Responses to these statements after CAI exposure showed that the students still exhibited a preference toward conventional methods, but they were significantly more favorable toward auto-tutorial techniques.

Responses to statements 4 and 5 showed that the students agreed that they liked the freedom of auto-tutorial instruction and that most students would use auto-tutorial facilities much more if they were located in convenient places. They further agreed in statements 10 and 12 that they would like being able to go to an auto-tutorial facility both to learn and to review basic information for their courses. Also, the students were slightly less willing to agree that a) they liked being able to go to an auto-tutorial facility at their convenience rather than being required to go to a scheduled class or b) auto-tutorial instruction was better than teacher contact in learning routine concepts.

Responses to the attitude statements after CAI exposure generally exhibited attitudes that were interpreted to be more favorable toward auto-tutorial instruction. Analyzing these changes in attitude in terms of the face validity of the items suggested that CAI was a useful experience for the students.

BIBLIOGRAPHY

Allen, M. W., Barbara W. Bigelow, et. al., "Computer Assisted Instruction User's Manual," 2nd Ed., Ohio State University, January, 1975.

"Approaches to Improved Teaching--Learning Outcomes," 1969 NCR Symposium on Improvement of Instruction, University of Illinois, Urbana, Illinois.

"Establishing Priorities in Instruction," Proceedings--RICOP 1973 Conference, University of Connecticut, August, 1973.

French, Charles E., "Selected Alternative Programs for Bringing the Real World to the Undergraduate Classroom," American Journal of Agricultural Economics, Vol. 56, No. 5, December, 1974.

Hahn, David E., Glenn C. Himes and Jon Brandt, "AGECON," Unpublished computer course listing for Agecon--00, IRCC/CAI, Ohio State University.

Kendrick, James G., "Techniques for Motivating Students," American Journal of Agricultural Economics, Vol. 55, No. 4, Part II, November, 1973.

Luskin, Bernard J., "Computer-Assisted Instruction: A Dream and a Reality," Occ. Report, UCLA Jr. College Leadership Program #15, July, 1969.

"Toward Better Teaching," Instructional Newsletter, Colleges of Agriculture, Forestry and Home Economics, University of Minnesota, Vol. 6, No. 2, February, 1973.

"Relating Principles of Learning to Instructional Activity," 1967 NCR Symposium on Instruction, University of Illinois, Columbus, Ohio.

Rowen, E. A., "Practical Tips on Training with CAI," Training in Business and Industry, June, 1973.

Stitzlein, James I., David E. Hahn and Glenn C. Himes, "The Use and Evaluation of Computer Assisted Instruction for Teaching Introductory Principles of Production Economics," Department of Agricultural Economics and Rural Sociology, ESO No. 108, The Ohio State University Columbus, Ohio, August, 1972.